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Dynamic Transmission Electron Microscopy (DTEM)

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A dynamic transmission electron microscope (DTEM) has been developed at Lawrence Livermore National Laboratory (LLNL) that permits dynamic phenomena in materials systems to be observed with both high spatial (~1 nm or better) and high temporal (~1 μs or faster) resolution. The high temporal resolution is achieved by using a short-pulse laser to create the pulse of electrons through photoemission. This pulse of electrons is propagated down the microscope column in the same way as in a conventional high-resolution TEM. To synchronize this pulse of electrons with a particular dynamic event, a second laser is used to "drive" the sample a defined time interval prior to the arrival of the laser pulse. An important aspect of this DTEM is that one pulse of electrons (a typical 10 ns pulse contains ~10^8 electrons) is used to form the whole image, allowing irreversible transitions and cumulative phenomena such as nucleation and growth to be studied directly in the microscope. In this presentation, a summary of the development of the DTEM will be described. The potential improvements in spatial and temporal resolution that can be expected through the implementation of upgrades to the lasers, electron optics, and detectors will also be discussed, along with the impact of new *in situ* gas and liquid stages to study catalysts and biological systems.

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